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The Critical Path to Success for Openhole Completions

Fluid Design and Execution

Charlie Svoboda
MI SWACO
Why Do We Drill and Complete Openhole?

1. It is easy.

2. Everybody’s doing it.

3. It gives greater exposure to the reservoir.
   1. Greater incremental productivity
   2. Lower drawdown pressure
   3. More even production across reservoir
   4. Greater ultimate recovery from reservoir
   5. Extended facility life
Fluid Design to Balance Needs

Reservoir Requirements
- “Non-Damaging”
- Sand Control Needs
- Well Type – Prod/Inj
- Well Fluid – Oil/Gas/Water

Drilling Requirements
- Wellbore Stability
- Pressure Control
- ROP
- Directional Control

Goal
- Reservoir Capability

Success
- Unimpeded Production w/ Managed Solids
- On Time & Under $
Drilling Issues

- Inhibition/ Wellbore Stability
  - Interstitial
  - Interbedded
    - Chemical
    - Mechanical
- Well Control
- Thermal Stability
Drilling Issues - continued

- Lubricity
  - Mechanical Coefficient of Friction
  - Stuck Pipe Tendency
- Fluid Friction - Hydraulics
- Drillability
  - Rate of Penetration (ROP)
  - Hole Cleaning
  - Directional Control
    - Rotating
    - Sliding
Reservoir Issues – “Non-Damaging”

- Invasion Control
  - Pores/Permeability
  - PSD/Filtration Control

Goal:
Thin External Filtercake
More “Non-Damaging” Reservoir Issues

- Compatible Chemistry
  - Mineralogy
    - Dissolution
    - Swelling
    - Dispersing
  - Formation Fluids
More “Non-Damaging” Reservoir Issues

- **Well Type**
  - Producer / Injector
  - Fluids – Oil / Gas / Water
- **Contamination Impact**
  - How much?
  - What Type?
- **Contingency Products**
  - Lubricants
  - Shale Inhibitors
  - Lost circulation Material

0% Injection post flowback

75% Injection post flowback
Completion Issues

- **Fluid Compatibility**
  - Drilling/Completion
  - Completion/Reservoir
  - Breaker/Reservoir
  - Drilling/Completion/Breaker?/Reservoir

- **Equipment Compatibility**
  - Screen Plugging
  - Corrosion
  - Elastomers
More Completion Issues

- Degree of “Forgiveness”
  - Barefoot
  - Predrilled
  - Slotted liner
  - Wire Wrapped Screen
  - Premium Screen
  - Expandable Screen
  - Openhole gravel pack

More “Forgiving”

More “Unforgiving”
More Completion Issues

• Process Compatibility
  - Tools permit all of completion process
  - Proper fluids in the correct place at the appropriate time with correct placement rate
  - Efficiently remove previous wellbore fluids
    - Appropriate chemistry
    - Sufficient volume
    - Correct Hydraulics

• Contingency Flexibility
  - Losses
  - Equipment failure
DON’T forget PRODUCTION!!!!

- When does production/injection begin?
  - 1 week, 6 months, 2 years……
  - Well test before - How long?
  - Immediate injection
  - Remoteness
- What will happen downhole?
  - Settling / Separation
  - Subsequent laterals?
  - Emulsion development
  - Corrosion
Production / Injection

- Suspension Fluid?
  - Fluid – Oil based vs. Water Based
  - Density
  - Solids
    - Amount
    - Size / Type – Plugging / Settling / Erosion
  - Compatibility
    - Fluids
    - Metallurgy
    - Elastomers
  - Stability
    - Separation/Settling??
Production / Injection

• Subsequent Stimulation
  ➢ Acidization
  ➢ Fracturing

• Production Facility Requirements / Location
  ➢ Solids
  ➢ Emulsion
  ➢ Corrosion
Select from the Vast Array of Fluids

<table>
<thead>
<tr>
<th>Water Based</th>
<th>vs.</th>
<th>Invert Emulsion</th>
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</thead>
<tbody>
<tr>
<td>Monovalent</td>
<td></td>
<td>Conventional</td>
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<tr>
<td>Divalent</td>
<td></td>
<td>Reversible</td>
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<tr>
<td>Formate</td>
<td></td>
<td>Low Solids</td>
</tr>
<tr>
<td>Solids Free</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridging Agent</td>
<td></td>
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<tr>
<td>Breaker</td>
<td>vs.</td>
<td>No Breaker</td>
</tr>
<tr>
<td>Disperse</td>
<td></td>
<td>Flowback</td>
</tr>
<tr>
<td>Dissolve</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Evaluation / Planning / Testing

- Formation Damage Testing **NOT** the Ultimate Test
- Look beyond the number (% return)
  - Filtration/Filtercake quality
  - Relative perm changes
  - Flow initiation pressure
  - Understand the steps

Be careful about overcomplicating the Test
Evaluation / Planning / Testing

- Formation Damage Testing **NOT** the Ultimate Test
- Fluid Integrity
  - Temperature
  - Solids Contamination
- Fluid Compatibilities
  - Scale
  - Corrosion
  - Elastomers
  - Emulsion

**Permeability Comparison Test #11**

- Init. Inject after Cleanup
- Inject. After Prod. Flow
- Base Perm.
- Prod. Flow Back

**Fluid Integrity**

- Temperature
- Solids Contamination

**Fluid Compatibilities**

- Scale
- Corrosion
- Elastomers
- Emulsion

**Formation Damage Testing**

- NOT the Ultimate Test

**Fluid Integrity**

- Temperature
- Solids Contamination

**Fluid Compatibilities**

- Scale
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**Formation Damage Testing**

- NOT the Ultimate Test

**Fluid Integrity**

- Temperature
- Solids Contamination

**Fluid Compatibilities**

- Scale
- Corrosion
- Elastomers
- Emulsion
Planning / Testing / Evaluation

- Breakers – Chemical CleanUp
  - Timing
  - Efficiency
    - Cake removal
    - Formation Impairment
- Production Screen Testing
- Full Sequence Simulation Testing
  - Drill
  - Displace
  - Run Completion
  - Chemical Breaker
  - Produce
Field Testing

- Standard
  - Density, Rheological Properties, Chemistry
- Low Shear Rate Viscosity
- Fluid Loss
  - Permeable Media NOT Paper
- Breaker Insolubles
- Production Screen Testing
- Pre-agreed Treatment Matrix
  - Solids Control Limitations
  - Premix Dilution
Keys to Success

Plan Thoroughly – Include adequate time and consider the complete process

• Cooperate
  - Operator (Office, Lab, Field)
  - Fluid provider
  - Tool provider(s)
  - Pumping service provider
More Keys to Success

- Agree on a plan
  - Compromises
  - Contingencies
    - Breakers
    - Losses
- Follow the plan
- Analyze performance
  - Well performance
  - Operational performance
- Adjust where needed for future projects
  - Learn
  - Don’t reinvent unless absolutely necessary
Where has this worked?

And many more………..

Routinely

2 wells

5 wells

Generally

Everywhere is possible!!!!!!
More Details to Projects

- SPE 98347
- SPE 98242
- SPE 96830
- SPE 96828
- SPE 95024
- SPE 82278

It Really is EASY